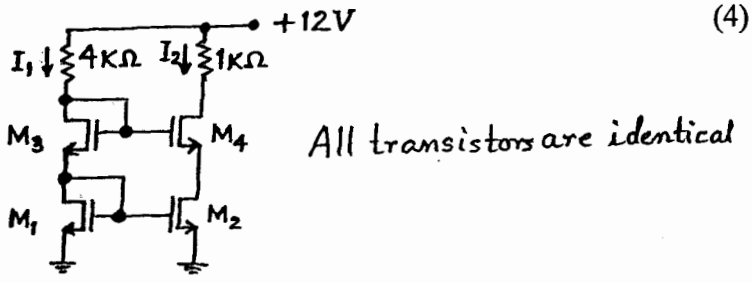
INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date: 20.4.2012 AN Time: 3 Hrs. Full Marks: 50 No. of students: 251
Spring Semester 2011-2012 Dept. of E&ECE Sub. No. : EC 21008 / EC 21010
2nd Yr. B.Tech.(H) Sub. Name: ***ANALOG ELECTRONIC CIRCUITS***

Instruction: ANSWER **ALL** THE **SIX** QUESTIONS
ANSWER TO ALL THE PARTS OF A QUESTION SHOULD BE TOGETHER.

1. (a) Draw a simple current mirror circuit containing β-helper transistor for 1:2 mirroring ratio. Given that β of all the transistors are equal to 100 and Early voltage of all the transistors are very high. If the current in the mirroring branch is 2 mA, then what is the precise value of the current in the mirrored branch? Derive the necessary expression of the mirrored current. (6)

   (b) Refer to the circuit shown in the figure below. Given that transconductance factor $K = 1\ mA/V^2$, $V_{th} = 1$ Volt, $\lambda = 0.02\ V^{-1}$. Find the values of I_1 and I_2. What is the value of small signal resistance looking into the drain of transistor M_4. (4)



2. Draw a differential amplifier using *n*-MOS transistors for differential pair with resistive load and 1 kΩ resistor as its tail bias. Find the values of the load resistors such that for 4 Volt input common mode level, the output common mode voltage is 6 Volt. Calculate its common mode and differential mode gains in mid frequency range. For one input equal to 4 Volt and the other input equal to (4 + 0.1 sin (ωt)) Volt, find the expressions of the signals at the two outputs of the amplifier. Given that transconductance factor $K = 1\ mA/V^2$, $V_{th} = 1$ Volt, supply voltage = 10 Volt, $\lambda \approx 0$. (8)

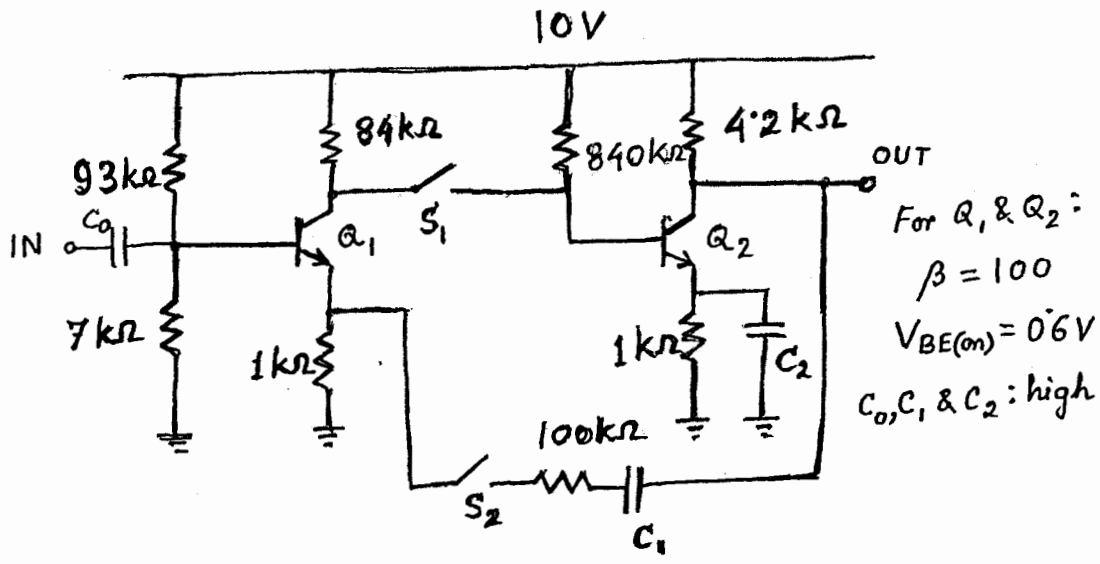
3. Draw a voltage-shunt feedback system cascaded with a current-series feedback system. Voltage gain, input resistance and output resistance of the forward amplifier in the first feedback system are 100, 2 kΩ and 4 kΩ respectively and those of the forward amplifier in the second feedback system are 40, 2 kΩ and 4 kΩ respectively. Feedback networks are ideal and the value of the feedback factor of the feedback networks in the first- and the second systems are 100 μA/V and 1 V/mA respectively. Calculate the input resistance, the output resistance and the overall voltage gain of the complete cascade system. (8)

[P.T.O]

4. Transfer function of a differential to single-ended amplifier has low frequency gain of 400 and two left hand side poles are at 1 kHz and at 200 kHz. The amplifier is used in a feedback configuration with a feedback factor of 0.25. Neatly sketch the magnitude and phase of the loop gain of the feedback system. Calculate its phase margin. Calculate the position of the poles of the feedback system. What should be the value of the feedback factor for which the system is stable with a phase margin of 60°? (8)

5. Draw the circuit diagram of an L-C oscillator and derive the necessary conditions for its oscillation. Draw the circuit diagram of a phase shift oscillator and derive the necessary conditions for its oscillation. (8)

6. Refer to the two-stage amplifier circuit shown in the figure below. Calculate the small signal voltage gains of the first stage and the second stage individually (switches S_1 and S_2 are open). Calculate the overall voltage gain of the two-stage amplifier in mid-frequency range when S_1 is closed and S_2 is open. Calculate the overall voltage gain of the two-stage amplifier when both S_1 and S_2 are closed. (8)



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